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MINERAL RESOURCES IN WAR AND THEIR BEARING ON PREPAREDNESS

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THE raw materials of war are men and minerals. The one stands in immediate contact with the enemy; the other lies back of the organization that supplies the munitions of war. The first has always been recognized as of prime importance; the second has been forced into prominence only by the unprecedented conditions of the European contest. But even now attention is too exclusively focused on the *industrial* aspects of the problem of preparedness, and too little care has been devoted to the ultimate sources of the materials of war, to a study of mineral resources from a military standpoint.

War has changed from an art to a science. It has come to be a large-scale engineering operation—a conflict of vast quantities of materials, handled by skilled labor, directed by expert knowledge. It is now a matter fundamentally of applied physics, chemistry and geology.

A result of the development of war along material lines has been the tendency to reduce the men on the battlefield to a dead level of equality. The bravest or the most numerous army no longer wins; the victor is the army best equipped, the one with the best home organization back of it—ultimately the troops of the country that commands the largest supply of coal, iron and fertile soil. The present war, indeed, has been termed by various writers "a war of coal and iron," "a war of metals," and the like.

The manufacture of most of the munitions of war, and of actually every implement of fighting, depends upon some mineral resource. Guns, projectiles and armor plate demand iron, copper, zinc, lead, antimony, manganese, nickel, chromium, tungsten, molybdenum; not one, or several, but all. The lack of a critical steel-hardening metal, though used in small quantities only, would render the most extensive iron deposits void for military purposes. This England discovered to her discomfort at the beginning of the War; to her disaster, had command of the seas not been hers. Explosives require nitrogen, sulphur, carbon, aluminum, and certain organic products obtained from the destructive distillation of coal. The railway, the ocean vessel, the motor truck, the aircraft, all depend upon coal or oil and many metals. Without copper and platinum, the telephone and wireless would remain silent. Even the surgeon draws many of his most essential drugs from coal-tar derivatives; while food and clothing, without which all other supplies would avail nothing, are direct or indirect products of the soil, for the quickened production of which potash, phosphates and nitrates must be available in abundance.

And not only must an army be munitioned, it must also be financed; and here a complexity of factors enters, not the least of which is the activity of the mining industry in general and of the supply and output of gold in particular. The fact that at the outbreak of the European war the British Empire had long been producing about three fifths of the world's gold, while the Central Powers were contributing less than 1 per cent., introduced an economic condition whose significance would have been more apparent had circumstances been reversed and Germany, and not the Entente, been the great purchaser of supplies on the American market. The Central Powers could better afford to be without great reserves of ready gold than their enemies.

In a table of the eighty chemical elements composing the universe, I have just counted thirty that are required in modern warfare. Lacking these, or the ability to obtain them, no nation can stand by virtue of superiority in either numbers or quality of men. The want of even a single essential may prove disastrous.

Countries rich in developed resources, therefore, are much better prepared for war than those whose mineral resources are scant or imperfectly developed. In fact, no country can become a great world power without extensive and varied mineral wealth. The British Empire, the German Empire, and the United States have achieved this end; the Russian Empire, China, and a confederation of South American republics, to include at least Brazil, Chile, and Bolivia, have this possibility. Argentina is the most exclusively agricultural country in the world, yet it is certain that she could not obtain a dominant position on that alone; for such an accomplishment, alliances with neighbors rich in minerals would be essential. An embargo on coal shipments from the United States under present circumstances would seriously embarrass, if not disrupt, her economic life.

Germany could not have maintained her stand in the present war had her territory been poor in variety of minerals or had not her chemical skill risen to fill gaps in her natural products. Of essential minerals, she has probably felt a serious stringency only in copper, nickel, aluminum, tin, antimony, manganese, petroleum, and nitrogen; but her chain of strength was kept from breaking at these weaker points by accelerated metallurgical and chemical developments, the extension of mining to low-grade deposits, heavy importations at the outset from Norway and Sweden, and probably also by anticipation and storage of these very products in large quantities in advance of hostilities. Her supply of iron would have proved inadequate if the events of 1871 had not placed in her hands the great iron-ore fields of Lorraine, which more than doubled her reserves of this metal—an advantage not generally appreciated at the time, as a suitable process was then lacking for working these low-grade ores. But their significance became apparent enough in 1914 when the German line embraced the extension of these fields lying in French territory east of Verdun and the French iron industry was thereby deprived at a single stroke of over 85 per cent. of its supply of ore, which was soon diverted into German blast-furnaces. It is surely the irony of fate that Germany to-day is practically waging the war with iron drawn from territory formerly French and worked into steel by a process devised by two Englishmen!

England has abundant iron and coal, but is deficient in most other mineral products of military significance. France is a manufacturing nation with few mineral resources, and of these her most important, the coal and iron fields adjoining Belgium and the German frontier, were captured early in the War. Russia (including Siberia) is a country rich in variety and quantity of minerals, but not only are these resources for the most part undeveloped, but their very distribution and extent are imperfectly known. In consequence, Russia has more men than she can adequately arm and munition. Industrial organization for war is one problem and can be quickly arranged for—behold England; the development of a country's resources is a different matter and can not be accomplished in a brief period of years—that Russia has learned to her loss. Therefore, it has devolved upon the British navy to maintain the command of the seas, not only that England herself might be provisioned, but that her allies might be supplied with the raw materials of war which their own territories alone were unable to furnish.

Looking further, we see in China a region of vast extent with a mineral wealth almost wholly undeveloped, to a large extent unknown, yet shown by successive explorations to be of great potentialities. For this and other obvious reasons, China is unprepared for a struggle with even a third-rate power; yet she has the raw materials of a world power. It is not unreasonable to suppose that Japan, herself rapidly developing to the limit of her restricted territory and resources, is seeking new fields for expansion; she has doubtless many times had visions of what an organized China might be; certainly those who would impute to her ambition designs against the distant shores of California, forget that at her very door lies a country probably nearly as rich in a material way as America ever was. China developed, we may have Japan to reckon with; as it is, the resources of China must appeal to Nippon as more alluring than the vague idea of a Japanese state in North America.

II

Not only is war to-day directly dependent upon mineral resources, but the development of the art of war through the ages has followed rather closely the advancing exploitation of mineral deposits. Stages in the upward progress of primitive man indeed are actually marked by the implements used by him in the chase and in war, according as these were of rough stone, of polished stone, of bronze or of iron. Lucretius, the Roman poet, recognized this fact two thousand years ago when he wrote:

> Weapons of old were hands, nails, and teeth, and stones, and boughs broken off trees, and flaming fire, as soon as it had become known. Afterwards the use of iron and copper was discovered, but the use of copper was earlier than that of iron; for it is easier to work and is found in greater quantity.

The accounts of the earliest wars bristle with spears, javelins, helmets, arrows, and catapults—all products, in part at least, of mines and quarries. The stirring lines of Homer resound with the clash of arms, and every school-boy knows the trappings and implements used by Cæsar in pressing his Gallic Wars. Ancient warfare was dependent upon stone, iron, bronze (copper and tin), and oil.

The two greatest inventions of the Middle Ages were printing and gunpowder. But the printing press is not our theme, however much it is dependent on lead and antimony or is now gorging itself on the details of modern fighting. When a German monk by the name of Schwartz (although there are some who would claim the honor for Roger Bacon) ground up a mixture of charcoal, sulphur and saltpeter, in the seclusion of a fourteenth century cloister, he loosened a force that was destined to shake the ages. The contribution of this early Teuton militarist altered the whole course of war; seized upon by the forward sweep of western thought, the principle of violent disruption was not allowed to sink beneath the lethargy of inaction, as had happened ages before in China. Soon the arquebus replaced the spear, and Mars himself, like the American Indian a little later, must have been surprised at this new and fearful "speaking death."

It is not necessary here to trace the development of the implements of war from medieval to modern times. The very names of blunderbuss, matchlock, muzzle-loader; of battle-axe, rapier, cutlass, saber; or of pike, lance, bayonet will call up vivid pictures of successive stages; while the appliances used in recent years are too familiar to need recounting. From the sixteenth to the middle of the nineteenth century, chemical elements of principal military note were iron, lead, carbon, sulphur and nitrogen.

Of these, nitrogen was critical. The available supply of this element was limited, in spite of its abundance in the atmosphere. It could be obtained only from sporadic deposits in caves, from the surface of some soils in semi-arid regions, and from accumulations of refuse matter—all undependable in time of need. A plan was later developed for inoculating the soil with colonies of nitrifying bacteria, and for a period niter plantations were common industries in Europe, and even in this country at the time of the Civil War.

But any widespread manufacture of explosives was impossible until the discovery in 1821 that the desert of Tarapacá near the west coast of South America was underlain by a blanket of sodium nitrate gave to the world an unexampled source of the elusive constituent. The development of these nitrate fields in the most unmitigated desert in the world, against serious political and climatic obstacles, advanced the arts of peace no less than those of war and rendered possible the developments in mining and transportation that have characterized the last half-century. The total effect upon civilization of this mineral occurrence, which a single rainy season would wash away, can scarcely be estimated.

It is now clearly recognized that the Chilean deposits will not last always, nor could they be relied upon by a country in periods of effective blockade. These are facts which have stimulated the development of the by-product coke oven, which yields nitrogenous compounds on the distillation of coal, and of several processes for separating nitrogen from the atmosphere and fixing it in usable form—advances that have been carried further in Germany than elsewhere, much to the advantage of that country in the present struggle.

III

As economic factors in shaping history, mineral resources have played an important rôle. In particular they have been a direct or contributing cause of many wars. The war between Peru and Chile in 1879–82 and the Boer War form two notable examples.

The Peruvian-Chilean war grew directly out of the development by Chilean interests of the nitrate fields, which extended from northern Chile across what was formerly a part of Bolivia into Peru. The conditions were ideal for trouble—a valuable mineral deposit, exploitation by foreign capital, unstable government, excitable temperaments. The result: Chile has now a monopoly on sodium nitrate, Bolivia is without seacoast, and Peru is minus her rich province of Tarapacá. The acquisition has made Chile the most prosperous country in South America, save one; her royalties from these fields sum up to hundreds of millions of dollars, and her very existence is bound up, as that of no other country, with the production of a single mineral deposit.

The Boer War was a by-product of gold mining in the Transvaal. The Rand district, discovered in the late eighties, drew the usual rush of gold-seekers, which met with disfavor on the part of the Boers. But the richest gold deposits the world has ever known had to produce, in spite of economic and political obstacles devised by Kruger and his government. The relations between the "foreigner," which meant the mining interests, and the Boers grew more and more strained; then came the Jameson Raid in 1896 and finally British intervention in 1899. Now the Rand mines are producing over $15,000,000 a month and aiding to finance the European struggle. Thus we have a literal illustration of the statement: "Gold the producer of War; War the consumer of Gold."

The desire for mineral wealth has always been a powerful motive in directing discovery and settlement. The Spanish Conquest in the two Americas forms a romantic example of men lured to great deeds by the lust for gold. The hope of finding the fabled "Land of El Dorado" was a very real incentive to the adventurers who followed Cortes, Pizarro and Quesada on their wild and successful expeditions. In more recent time, the California gold rush of '49, the stampede to the Australian gold fields two years later, the discovery of diamonds in South Africa in 1869, and the Yukon fever of '98 are events which opened up continents and made empires of the waste places of the earth.

The Mexican situation to-day, at bottom, is rendered an international problem by the fact that foreign capital is exploiting the mineral wealth of a country—and Mexico's mineral wealth is great—in opposition to the wishes of many of its inhabitants.

Mineral resources play a rôle, if ofttimes an unspecified one, in the diplomatic relations between nations. A nation poor in mineral wealth tends to seek alliances with powers strong in the essentials lacking. The contest of European capital in developing backward or semi-civilized regions, the rivalry thereby entailed, and the desire on all sides to gain fields for future exploitation were factors of importance in shaping circumstances that led to the present European war. And we may be sure that the international rôle of mineral resources will assume greater importance in the future, when the stress of waning mineral reserves becomes more acutely felt.

IV

The intimate relation existing between war and mineral resources is shown nowhere better than in a plot of metal prices in the United States over the past three years. Under the stimulus of abnormal demand, munition metals have soared in value beyond all precedent, and a chart of their wild careening now looks more like an involved seismograph than a sober table of accurate facts. The different metals have responded differently to the war influence, showing an individual sensitiveness to the changed conditions in Europe; but in general the effect has been an immediate though somewhat small drop in price, followed by a sharp climb, in some cases to figures many times the normal, in turn succeeded by marked oscillations, but a general maintenance of a high-level average.

Pig iron, to consider the most fundamental metal first, held close to $15 a long ton during the first year of the war, but in July, 1915, began to climb slowly but surely until it reached a height of over $30 by the end of 1916. Copper, whose average price for thirty years preceding the war was almost 14 cents a pound, and during 1912–13, 16 cents, dropped a little during the first few months of hostilities, but recovering early in 1915 reached 20 cents before the year was half over and ended 1916 above 31 cents. The career of zinc was even more spectacular; long used to a price that hovered around 5⅓ cents per pound, it responded with a few months to war conditions (the centers of the zinc industry abroad lay in Belgium and Germany), and during the first six months of 1915 jumped from 6 cents to 21 cents, only to fall back to 15 cents by December; in 1916, it experienced a sudden set-back upon the reorganization of the European zinc industry, sinking to 8 cents during the summer months and ending the year close to 11 cents. The war caught silver at 55 cents per ounce; its price thereupon slowly went down until April, 1916, when it abruptly advanced 10 cents, going to 74 cents in May and remaining near that figure through 1916. Antimony was formerly of limited use, but the war created a large demand, and "this being precipitated in an unprepared mining industry, the price rose by leaps and bounds"; originally 8 cents a pound, this metal commanded 42 cents at the beginning of 1916, and 46 cents in March of that year, but war-inspired production in China began then to be felt and it dropped to 14 cents by December. Aluminum entered the war at 17.6 cents a pound; 1916 saw its price average 60.7 cents. Other examples might be cited, but these are sufficient to show that the prices of the common metals in a peaceful country were increased fifty to several hundred per cent. because of demands put upon them by a foreign war.

These conditions have given an unparalleled impetus to mining throughout the world, and especially in the United States. The mining industry of this country is enjoying the wildest prosperity in its history; American mining companies that publish their dividends paid $170,000,000 in 1916, against $78,000,000 in 1915. New mines are being developed, old mines reworked, and many deposits are now producing which could not be operated under normal conditions. The return of former prices would spell disaster for many enterprises.

The zinc industry has been affected in a pecular and interesting manner. In 1913, of the world's supply of this metal, the United States produced one third, Germany one fourth, and Australia one fifth. Most of the foreign ores were smelted in Germany and Belgium, Australia's output from the famous Broken Hill mines going almost entirely to these two countries. Little zinc was smelted in England; the smelteries in France lay near the eastern frontier. The entire zinc industry of

Europe therefore passed into German hands; and the United States was called upon to supply the shortage of zinc among the Allies, who found themselves in the position (one which might have easily been foreseen) of having plenty of zinc ore, but no means of rendering it useful. The price of zinc soared; American zinc flourished as never before; the Australian mines faced disaster. Then the situation readjusted itself; smelters were built in England; electrothermic furnaces sprang up in Norway and Sweden; Japan, China, and Canada became producers; new markets, among them Japan, were found for the Australian ore. The price dropped; the stringency cleared up.

The Russian mineral industry felt keenly the effects of war, as it was wholly unprepared to get along without the markets of Germany and Austria, and as there were many gaps in its production which these countries had been relied upon to fill. Under the stress of circumstances, then, the Russian government did more for her mining industry in a few months than it had previously done in years: a systematic study of the mineral resources of the empire was undertaken; a corps of geological engineers was sent to carry on prospecting explorations in the Urals, the Caucasus, and Siberia; the land tax on gold fields was reduced; roads tapping mining regions were improved; and in general a lively interest was evinced in an eleventh-hour development of neglected mining opportunities.

France, deprived of her rich iron-ore fields near Verdun, was forced into quickened exploitation of lower-grade deposits in other parts of her territory; but the loss of her principal coal-fields could not be compensated and she is to-day suffering a serious shortage in fuel. China's mineral output has become a significant economic factor; while Japan is working overtime, experiencing somewhat the same era of prosperity that the United States has been enjoying. As to Germany, we may be sure that her mining industry, formerly highly efficient, has been the focus of much additional study, and that under the spur of necessity and beyond the influence of normal competition, mining operations have been extended to many low-grade deposits never before workable as ore.

The mining boom has of course stimulated those sciences that have to do with the treatment of the crude mineral products as they come from the mine—metallurgy, ore dressing, and industrial chemistry. The new and fairy-like "flotation method" of separating ore minerals from worthless rock by floating off the *heavy* particles by means of oily froths has in particular found this a favorable time for development; under the balmy breezes of bonanza prices this infant has grown into a lusty youth of already notable achievements and even greater potentialities. Electric smelting, to cite merely one more example, has been forced past the experimental stage, and the past three years has witnessed the installation of more than one hundred electric furnaces, especially in Norway and Sweden, for the manufacture of steel alone, not to mention notable electrothermic developments along many other lines.

While the European War has sped up the production of gold, it has exerted a much greater effect upon the commercial movement of the metal. For the first time in history, this country has accumulated such enormous gold reserves that it has become not only the principal gold-holding nation of the world, but now has more gold than any other nation ever had. The world's supply of gold, exclusive of jewelry and works of art, is estimated at eight billion dollars, of which the United States now holds approximately three billions (2,700,000,000 on Nov. 1, 1916). Since December, 1914, the gold coming to this country has been equivalent to the production of the rest of the world during this period. In short, due to the war, the gold production of the world is finding its resting place in the United States. This situation is filled with grave concern for the future; its effect on the present, as a contributing factor to high prices, is obvious.

The impetus given the mining industry by the present war, however, can not be looked upon as an unmixed blessing. Apart from the destruction of mining activity in some sections, as in parts of Belgium, France and Roumania, and the serious setback given it in others, as in Australia, the economic loss involved in the total destruction of vast quantities of material, the existing supplies of which are limited, overbalances the financial gain and technical advance growing out of the war stimulation. The war has proved a serious drain on the mineral resources of the world in general and of the United States in particular, bringing the period of exhaustion of certain of these materials nearer. That, the people living in the fringe of depletion of such products will realize more vividly than we.

V

We have seen that war and mineral resources are intimately related; that mineral products are essential to the carrying on of war; that they have always been essential, but increasingly so; that they have, in certain instances, actually been the cause of war; and that in turn they are strongly affected by war conditions. It remain now to consider briefly the situation of the United States as regards its mineral resources in event of continued war—an important phase of preparedness.

The mineral resources of the United States happily are extensive and varied. They are also well-developed. This country is not only the world's greatest producer of mineral wealth, but "possesses greater reserves of most of the essential minerals than any other nation." Moreover, thanks to the well-directed efforts of the United States Geological Survey, we know more about our mineral resources than does any other nation about its own, save perhaps Germany. The United States therefore is to-day better prepared as regards the *presence* of fundamental resources of war than is any other nation, better prepared in this respect, indeed, than she is from an industrial or human standpoint. But the problems connected with the exploitation and conservation of deposits now known, with the development of new and low-grade deposits, and the means for filling gaps in our present production are all peace problems that merely become more acute in time of war.

The value of the mineral production of the United States in 1913 was practically $2,500,000,000. In that year she produced about 40 per cent. of the world's coal, 65 per cent. of its petroleum, 40 per cent. of its iron ore, 55 per cent. of its copper, 30 per cent. of its lead and zinc; and of its silver and gold she yielded 32 per cent. and 19 per cent., respectively.

The coal fields of the United States are inland, scattered, and distant from frontiers. Less than 1 per cent. of their total tonnage has been mined; they will last, even under increasing consumption, for several centuries. The incredibly wasteful methods of coal mining characteristic of earlier decades have been considerably improved upon; the chief waste now is the loss of energy during combustion and the failure to utilize more extensively the volatile portion for the manufacture of gas, ammonia, and coal-tar products. Radical changes in the utilization of coal are bound to come.

The petroleum fields of this country are likewise scattered, but those of California, producing two fifths of the domestic supply, are close to the Pacific coast. The life of the petroleum reserves is variously estimated at between twenty-five and one hundred years. Terrific waste has taken place in this industry; much is still going on. The production will be prolonged somewhat by the development of a suitable process for distilling on a large scale extensive deposits of oil-shale occurring in the west and perhaps lower-grade deposits in the east. The approaching exhaustion of the oil fields is already being felt in the climbing price of gasoline. The adoption of an oil-burning navy will prove a tremendous drain on the oil reserves of this country, and the question obtrudes whether a successful maintenance of our present naval program will not demand the control of the large oil pools of Mexico.

Eighty per cent. of our iron comes from the Lake Superior region. Lacking these immense deposits, our iron industry would be seriously, though perhaps not fatally, crippled. The unmined iron-ore of present workable grade in the United States is estimated to represent an eighty-year supply at the present rate of consumption; but low-grade deposits are present which under future conditions may be forced to yield for seven or eight centuries.

Of important mineral products, there are seven of which this country has no domestic supply *developed* to the point of satisfying her war-time needs.[1] These are potash, nitrates, manganese, tin, nickel, platinum and pyrite.

Potash is of peculiar significance, for heretofore our entire supply has come from the famous mines of Stassfurt in Prussian Saxony, a locality which indeed has long held a monopoly on the world's output of this material, so indispensable to modern agriculture and to many chemical industries. The exactions of the German Potash Syndicate caused the United States a number of years ago to realize the importance of developing a domestic source of supply, and consequently the government instigated a systematic investigation, which, accelerated by the cessation of imports during the war, has met with some success. At present, in addition to a small recovery made from a number of waste products, including the smoke from Portland cement plants, a growing production comes from salt lakes in California and Nebraska and from deposits of a potash mineral known as alunite under operation in Utah; while certain deep and surface brines and the giant sea-weed of the Pacific coast, known as kelp, whose ash runs to 30 per cent. potash, are under development and giving promising results. In addition, there are extensive deposits of silicate rocks ranging from 5 per cent. to 9 per cent. potash, which would furnish an unlimited supply, should a suitable chemical process be developed on an economic basis for making the extraction, now too costly for practical results.

Nitrogen, the basis of practically all explosives, and like potash essential to chemical technology and to agriculture, is drawn largely from deposits of sodium nitrate in northern Chile. Unlike most mineral occurrences, this seems to be unique; no similar deposits of consequence are known elsewhere, and hence Chile has been able to maintain a world monopoly on this valuable salt. The United States alone imports yearly over twenty millions of dollars worth of this material, a little over one third of the total exports. While abundant in the atmosphere, nitrogen is so inept at chemical combination that a large supply of electrical energy is required to obtain it from this source, a serious disadvantage in America where water power is not fully developed and electric power is at a premium. Nitrogen, however, is an important constituent of coal, most coals carrying over one per cent. of this element. But this nitrogen is returned to the atmosphere when the coal is burned, and only when the coal is distilled or converted into coke in a modern type of oven known as the by-product or retort oven is this valuable constituent recovered in the form of ammonia, which may be changed by a process now becoming successful into the nitric acid required by the explosive industry. A ton of coal so treated yields $1.50 in ammonia, gas, and a tarry residue convertible into drugs, dyes, explosives, etc., while the heat-producing portion is left behind as coke, which may then be burned as fuel, or employed, as most of it is, in the iron blast-furnace. The United States in 1913, the last year unaffected by war conditions, produced from coal $8,000,000 worth of nitrogen products, but this figure would have been nearly $30,000,000 had the nitrogen been recovered from all the coal coked; and much greater had a higher percentage of the total coal mined been distilled before combustion. But in spite of these facts, Congress in 1916 appropriated $20,000,000 for the construction of a plant for obtaining nitrogen from the atmosphere, but made no provision for stimulating a more extensive recovery of this element from coal—a one-sided action inimical to proper progress as tending to discourage the by-product development. In other words, we are paying $20,000,000 to recapture from the air part of the $20,000,000 worth of nitrogen yearly sent into it by wasteful coking methods!

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[1] A stringency is felt in regard to a few other important minerals, but it would carry us too far afield to consider them here.

Manganese is essential to the manufacture of steel. No substitute is known for it. Although there are many low-grade deposits in the United States, this country in 1913 imported nearly 90 per cent. of its supply, getting part in the form of an iron-manganese alloy from England and Germany, and part in the form of manganese ores from Russia, India and Brazil. The war cut off practically all the foreign sources except Brazil and of course stimulated the output of that country. But a shortage was created in the United States, which became acute; by April, 1916, the price was ten times the normal. The situation is now better, but a serious stringency is still being felt as the response of local ores is slow; were we suddenly isolated by the present war, " we should immediately need more time to bring the production of manganese up to our requirements than we should to create an army." In preparation for war, therefore, the problem of manganese is one of prime importance.

The United States is the greatest user of tin among all nations, her importation in 1913 being $46,900,000, about two fifths of the world's output. But she mines an insignificant quantity and that comes wholly from Alaska. Her supply is derived chiefly from Europe where ores from the Straits Settlements, from the island of Banca, off Sumatra, and from Bolivia come for smelting. Bolivia, with her increasing importance as a producer of tin ore, should be looked to as a direct source of crude material to be smelted here; and this has already been done to a limited extent. No adequate development of a domestic source of tin seems possible.

A small quantity of nickel is recovered in this country as a by-product in the electrolytic refining of copper, but there is no production from nickel ores, although nickel minerals are known at a number of localities. The world's nickel comes almost exclusively from Ontario, Canada and New Caledonia, most of the product of the former being shipped to the United States for refining before distribution and use.

Platinum, that rare and unique metal so essential to chemical research, is in strong demand throughout the world. In 1913 Russia produced about 93 per cent. of the world's supply, while the undeveloped deposits of Colombia contributed nearly 6 per cent., and the United States less than ½ per cent. The domestic production may be increased somewhat, but the more pressing problem is the conservation and proper use of the metal already in circulation.

The unusual shipping conditions arising out of the unrestricted submarine warfare have practically cut off the supply of pyrite from Spain, upon which the sulphuric acid manufacturers were largely dependent; a situation rendered serious by the large quantities of sulphuric acid required in the industries and for the preparation of phosphate fertilizer and explosives. The stringency is being tided over by the use of small reserves of pyrite on hand; and much attention is now being directed to the development of numerous low-grade pyrite and related deposits in the East, etc.; but the pyrite problem, while soluble, is not yet solved.

Preparedness is a complicated matter, involving the training of men, the organization of industry, the assembling of raw materials, and, behind, all the application of science to every phase of the problem. Preparedness, limited to the thesis of this essay, must *anticipate* the organized use of every mineral resource essential to war, which means practically every mineral resource. This involves study, investigation, exploration, organization, and conservation—rigorous, complete, scientific—which must be inspired and guided by the government. Much has already been done; much remains. And as mineral resources in the future will be more significant in determining the balance of power among nations than they are to-day, this problem becomes increasingly important at time goes on.

The writer hesitates, in conclusion, to make specific suggestions, as the manifold aspects of the problem can be adequately encompassed by no single individual. Yet he ventures to mention a few lines of activity, along which immediate action would yield a good return, whether peace comes soon or war continues. A detailed study of the mineral resources of the United States should be made from a military standpoint; the activities of the Geological Survey and the Bureau of Mines should be increased by enlarged governmental support; the topographic map of the United States as well as the geologic map should be pushed to completion; an adequate domestic supply of potash, nitrogen, manganese, pyrite and nickel should be rapidly developed, under governmental aid if necessary, and a thorough search instigated for tin and platinum; the War Department should engage a geologic staff; wastes should be eradicated from the mining industry by drastic means; conservation should be more thoroughly studied and more extensively applied, under governmental direction, in the light of military necessity; the antiquated mining laws of this country should be revised; a consistent plan of developing the public mineral lands, probably by a system of leasing, should be put into operation; governmental exploitation of public oil lands for military uses should be undertaken; the burning of crude oil and of uncoked coking coal should be strongly discouraged, if not actually legislated against; the further utilization of platinum for ornamental purposes should be heavily penalized; and finally the spirit of scientific research should be fostered in every way and be given its due place in the nation's life.

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[1] This has recently been undertaken.